DOCUMENT RESUME

ED 061 338 TM 001 567

TITLE	Production-Machine Operator (mach. shop) 609.885--Development of USES Aptitude Test Battery.
INSTITUTION	Manpower Administration (DOL), Washington, D.C. U.S. Training and Employment Service.
REPORT NO	TR-S-135
PUB DATE	Nov 66
NOTE	19p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Aptitude Tests; *Cutting Scores; Evaluation Criteria; Job Applicants; *Job Skills; *Machine Tool Operators; Norms; Occupational Guidance; *Personnel Evaluation; Test Reliability; Test Validity
IDENTIFIERS	GATB; *General Aptitude Test Battery; Production Machine Operator

ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

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Development of USES Aptitude Test Battery

for

Production-Machine Operator

(mach. shop) 609.885

TM 001 100

U.S. DEPARTMENT OF LABOR
W. Willard Wirtz, Secretary
MANPOWER ADMINISTRATION
BUREAU OF EMPLOYMENT SECURITY
Washington, D.C. 20210

Technical Report on Development of USES Aptitude Test Battery

For .....

Production-Machine Operator (mach. shop) 609.885
S-135

U. S. Employment Service
in Cooperation with
Pennsylvania and Wisconsin State Employment Services

November 1966

FOREWORD

The United States Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

Frank H. Cassell

Frank H. Cassell, Director
U. S. Employment Service

GATB Study #2191

DEVELOPMENT OF USES APTITUDE TEST BATTERY

For

Production-Machine Operator (mach. shop) 609.885

S-135

This report describes research undertaken for the purpose of determining General Aptitude Test Battery (GATB) norms for the occupation of Production-Machine Operator 609.885. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB, B-1002 Scores
G - General Learning Ability	75
F - Finger Dexterity	75
M - Manual Dexterity	80

RESEARCH SUMMARY

Sample:

50 male workers employed as Production-Machine Operators at Patterson-Kelly Company, Incorporated, East Stroudsburg, Pennsylvania and York Corporation, York, Pennsylvania.

Criterion:

Supervisory ratings

Design:

Concurrent (test and criterion data were collected at approximately the same time).

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Concurrent Validity:

Phi Coefficient (ϕ) = .38 ($P/2 < .005$)

Effectiveness of Norms:

Only 68% of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the S-135 norms, 81% would have been good workers. 32% of the non-test-selected workers used for this study were poor workers; if the workers had been test selected with the S-135 norms, only 19% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	68%	81%
Poor Workers	32%	19%

VALIDATION SAMPLE DESCRIPTION

Size: N = 50

Occupational Status: Employed Workers

Work Setting: Workers were employed by Patterson-Kelly Company, Incorporated, East Stroudsburg, Pennsylvania, and York Corporation, York, Pennsylvania.

Employer Selection Requirements:

Education: Prefers applicants with at least an eighth grade education.

Previous Experience: None

Tests: None

Other: Personal interview. Workers should be of average height and not weigh over 200 pounds; workers should be agile and able to withstand loud noises.

Principal Activities: The job duties for each worker are comparable to those shown in the Appendix.

Minimum Experience: All workers had completed an on-the-job training period of six months.

TABLE 2

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, and Experience

	Mean	SD	Range	r
Age (years)	36.6	8.7	22-54	-.030
Education (years)	10.1	1.9	6-15	.175
Experience (months)	78.4	78.8	6-144	.019

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002A were administered during the period July 1956 through December 1957.

CRITERION

The criterion data consisted of supervisory ratings of job proficiency. The shop foreman in each plant prepared one set of ratings for each worker under his supervision. Ratings were made at approximately the same time as the tests were administered.

Rating Scale: The USES Descriptive Rating Scale, Form SP-21, was used. The scale (see Appendix) consists of nine items with five alternatives for each item. The alternatives indicate the different degrees of job proficiency.

Reliability: Since only one set of ratings was obtained, no measure of criterion reliability is available.

Criterion Distribution:

Possible Range:	9-45
Actual Range:	17-44
Mean:	29.6
Standard Deviation:	6.6

Criterion Dichotomy: The criterion distribution was dichotomized into high and low groups by placing 32% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low criterion group as "poor workers." The criterion critical score was 27.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of tests and criterion data. Aptitudes Q and K which do not have a sig-

nificant correlation with the criterion were considered for inclusion in the norms because Aptitude Q had a relatively high mean and a relatively low standard deviation, the qualitative analysis indicated that Aptitude K was important for the job duties and it had a relatively high mean score. With employed workers, a relatively low standard deviation indicates that some pre-selection may have taken place and this restricted range of scores (low standard deviation) will depress the correlation between the aptitude and the criterion. A relatively high mean score with employed workers may also indicate some sample pre-selection. Tables 3, 4 and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis the aptitudes indicated appear to be important to the work performed)

Aptitude	
G - General Learning Ability	Required to set up machine, to understand written instructions or job orders with blueprints of parts to be machined, and to make accurate judgments when making adjustments during machining process.
S - Spatial Aptitude	Required to visualize finished product from blueprints and written instructions.
K - Motor Coordination	Required for accuracy and speed in positioning small controls and small hand tools.
F - Finger Dexterity	Required to manipulate measuring instruments, to place small controls in correct position, and to use small hand tools.
M - Manual Dexterity	Required to turn and position hand wheels and gear shift levers which set, start and stop machines.

TABLE 4

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

Aptitude	Mean	SD	Range	r
G - General Learning Ability	93.7	14.2	70-122	.284*
V - Verbal Aptitude	92.2	14.6	68-123	.263
N - Numerical Aptitude	92.3	14.4	55-124	.168
S - Spatial Aptitude	93.5	16.0	61-130	.217
P - Form Perception	91.1	17.0	52-130	.075
Q - Clerical Perception	94.2	13.2	68-120	.156
K - Motor Coordination	93.6	17.7	51-126	.227
F - Finger Dexterity	90.0	19.7	42-131	.291*
M - Manual Dexterity	100.9	18.4	51-148	.328*

*Significant at the .05 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X			X			X	X	X
Irrelevant									
Relatively High Mean	X					X	X		X
Relatively Low Standard Dev.	X	X	X			X			
Significant Correlation with Criterion	X							X	X
Aptitudes to be Considered for Trial Norms	G					Q	K	F	M

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of G, Q, K, F, and M at trial cutting scores were able to differentiate between the 68% of the sample considered good workers and the 32% of the sample considered poor workers. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For

two-aptitude trial norms, minimum cutting scores of slightly higher than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores slightly lower than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of G-75, F-75 and M-80 provided the highest degree of differentiation for the occupation of Production-Machine Operator 609.885. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .38 (statistically significant at the .005 level).

TABLE 6

Concurrent Validity of Test Norms G-75, F-75 and M-80

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	8	26	34
Poor Workers	10	6	16
Total	18	32	50

Phi Coefficient = .38
Chi Square (X^2) = 7.180
Significance Level = P/2 less than .005

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-22 which is shown in Section II of the Manual for the General Aptitude Test Battery. The OAP-22 norms (G-75, F-75, M-80) are identical to the S-135 norms.

GATB Study #2630 S-135

Production-Machine Operator (mach. shop) 609.885

Check Study Research Summary

Sample:
82 male MDTA trainees at vocational schools in Milwaukee, Racine, South Milwaukee and West Allis, Wisconsin who were tested in 1966.

TABLE 7

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Aptitudes G, S, F and M.

	Mean	SD	Range	r
Age (years)	26.1	9.3	16- 58	.025
Education (years)	11.0	1.5	6- 15	.220*
G - General Learning Ability	95.1	16.8	54-138	.624**
S - Spatial Aptitude	102.3	19.2	58-156	.550**
F - Finger Dexterity	91.9	21.6	37-141	.405**
M - Manual Dexterity	100.8	23.3	25-155	.232*

*Significant at the .05 level
**Significant at the .01 level

Criterion: *Instructors'* ~~Supervisory~~ ratings made on a Descriptive Rating Scale consisting of eight items and designed to evaluate performance on the most important aspects of the training. Each item has five alternatives corresponding to different degrees of training performance.

Design:
Longitudinal (tests were administered at the beginning of training and criterion data were collected at the end of training).

Principal Activites:
The job duties for each worker are those shown in the Appendix for the Validation sample.

Predictive Validity:
Phi Coefficient = .38 ($P/2 < .0005$)

Effectiveness of Norms:
Only 63% of the non-test-selected trainees in this sample were good trainees; if the trainees had been test-selected with the S-135 norms, 75% would have been good trainees. 37% of the non-test-selected trainees were poor trainees; if the trainees had been test-selected with the S-135 norms, only 25% would have been poor trainees. The effectiveness of the norms when applied to

this independent sample is shown graphically in Table 8.

TABLE 8

Effectiveness of S-135 Norms on Check Study Sample

	Without Tests	With Tests
Good Trainees	63%	75%
Poor Trainees	37%	25%

TABLE 9

Predictive Validity of the S-135 Norms
(G-75, F-75 and M-80) on the Check Study Sample

	Nonqualifying Test Scores	Qualifying Test Scores	Total Total
Good Trainees	9	43	52
Poor Trainees	16	14	30
Total	25	57	82

Phi Coefficient (ϕ) = .38
Chi Square (X^2) = 11.655
Significance Level = $P/2 < .0005$

SP-21·
Rev. 2/61

A-P-P-E-N-D-I-X

DESCRIPTIVE RATING SCALE
(For Aptitude Test Development Studies)

Score____

RATING SCALE FOR _____
D. O. T. Title and Code

Directions: Please read Form SP-20, "Suggestions to Raters", and then fill in the items listed below. In making your ratings, only one box should be checked for each question.

Name of Worker (print) _____
(Last) (First)

Sex: Male_____ Female_____

Company Job Title: _____

How often do you see this worker in a work situation?

- ☐ **See him at work all the time.**
- ☐ **See him at work several times a day.**
- ☐ **See him at work several times a week.**
- ☐ **Seldom see him in work situation.**

How long have you worked with him?

- ☐ **Under one month.**
- ☐ **One to two months.**
- ☐ **Three to five months.**
- ☐ **Six months or more.**

A. How much work can he get done? (Worker's <u>ability</u> to make efficient use of his time and to work at high speed.)

☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.

☐ 2. Capable of low work output. Can perform at a slow pace.

☐ 3. Capable of fair work output. Can perform at an acceptable but not a fast pace.

☐ 4. Capable of high work output. Can perform at a fast pace.

☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of his work? (Worker's ability to do high-grade work which meets quality standards.)

☐ 1. Performance is inferior and almost never meets minimum quality standards.

☐ 2. The grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.

☐ 3. Performance is acceptable but usually not superior in quality.

☐ 4. Performance is usually superior in quality.

☐ 5. Performance is almost always of the highest quality.

C. How accurate is he in his work? (Worker's ability to avoid making mistakes.)

☐ 1. Makes very many mistakes. Work needs constant checking.

☐ 2. Makes frequent mistakes. Work needs more checking than is desirable.

☐ 3. Makes mistakes occasionally. Work needs only normal checking.

☐ 4. Makes few mistakes. Work seldom needs checking.

☐ 5. Rarely makes a mistake. Work almost never needs checking.

D. How much does he know about his job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

☐ 1. Has very limited knowledge. Does not know enough to do his job adequately.

☐ 2. Has little knowledge. Knows enough to "get by."

☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.

☐ 4. Has broad knowledge. Knows enough to do good work.

☐ 5. Has complete knowledge. Knows his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

☐ 1. Has great difficulty doing his job. Not at all suited to this kind of work.

☐ 2. Usually has some difficulty doing his job. Not too well suited to this kind of work.

☐ 3. Does his job without too much difficulty. Fairly well suited to this kind of work.

☐ 4. Usually does his job without difficulty. Well suited to this kind of work.

☐ 5. Does his job with great ease. Exceptionally well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

☐ 1. Cannot perform different operations adequately.

☐ 2. Can perform a limited number of different operations efficiently.

☐ 3. Can perform several different operations with reasonable efficiency.

☐ 4. Can perform many different operations efficiently.

☐ 5. Can perform an unusually large variety of different operations efficiently.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

☐ 1. Almost never is able to figure out what to do. Needs help on even minor problems.

☐ 2. Often has difficulty handling new situations. Needs help on all but simple problems.

☐ 3. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.

☐ 4. Usually able to handle new situations. Needs help on only complex problems.

☐ 5. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How many practical suggestions does he make for doing things in better ways? (Worker's ability to improve work methods.)

☐ 1. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.

☐ 2. Slow to see new ways to improve methods. Contributes few practical suggestions.

☐ 3. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.

☐ 4. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.

☐ 5. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and only these factors, how acceptable is his work? (Worker's "all-around" ability to do his job.)

☐ 1. Would be better off without him. Performance usually not acceptable.

☐ 2. Of limited value to the organization. Performance somewhat inferior.

☐ 3. A fairly proficient worker. Performance generally acceptable.

☐ 4. A valuable worker. Performance usually superior.

☐ 5. An unusually competent worker. Performance almost always top notch.

Attachment 2 to
TESPL 2615

CHECK STUDY #2 RESEARCH SUMMARY SHEET FOR S-135

S-135 GATB #2816

Production Machine Operator (mach. shop) 609.885-022

Check Study #2 Research Summary

Sample:

237 (187 males and 50 females) trainees enrolled in ten-week MDTA courses as Production Machine Operators in Connecticut. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group composition is unknown.

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Aptitudes G, F and M. N=237.

	Mean	SD	Range	r
Age (years)	29.9	10.9	17-63	.016
Education (years)	10.3	2.0	4-16	-.208
G - General Learning Ability	82.6	16.9	32-132	.297**
F - Finger Dexterity	93.6	24.3	7-161	.263**
M - Manual Dexterity	104.3	24.1	27-174	.270**

**Significant at the .01 Level

Criterion:

Instructors ratings. The ratings were collected from 1964 through 1967.

Design:

Longitudinal (Tests were administered prior to or during early training.)

Principal Activities:

The job duties are comparable to those described in the Appendix for the validation sample.

Effectiveness of Norms:

Only 57% of the nontest-selected trainees used for this study were good trainees; if the trainees had been test-selected with the S-135 norms, 68% would have been good trainees. Forty-three percent of the nontest-selected trainees used for this study were poor trainees; if the trainees had been test-selected with the S-135 norms, only 32% would have been poor trainees. The effectiveness of the norms when applied to this independent sample is shown graphically in Table 11.

TABLE 11

Effectiveness of S-135 Norms
on Check Study Sample #2

	Without Tests	With Tests
Good Workers	57%	68%
Poor Workers	43%	32%

TABLE

Concurrent Validity of S-135 Norms
on Check Study Sample #2

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	51	85	136
Poor Workers	61	40	101
Total	112	125	237

Phi Coefficient (ϕ) = .22 Chi Square (X^2Y) = 11.3
Significance Level = $P/2 < .0005$

November 1966 S-135

FACT SHEET

Job Title: Production-Machine Operator (mach. shop) 609.885

Job Summary: Tends vertical boring mill, vertical turret lathe, engine lathe, grinder and radial drill to drill, groove, grind, shape or machine metal castings (brass, steel, aluminum, steel alloys). Examines job orders and blueprints of parts. Oils and brushes machine to removes dirt, shavings and drillings. Turns hand wheels or moves levers to shift gears. Periodically checks work, using micrometers and calipers, and finishes work to tolerances specified in blueprints. Positions lever to stop machine when work is completed; removes work from table and places it on hand truck. Assists in set up of machine.

Work Performed: Examines written instructions or job orders received together with blueprints of parts from Foreman, to determine the number and kind of parts required and the kind of metal stock or castings from which finished pieces are to be made. Obtains required amount of stock or rough castings from stockroom and carries stock to work place by hand or hand truck. Lifts heavy objects with electrically powered hand crane onto working area of machine (vertical boring mill, vertical turret lathe, engine lathe, grinder or radial drill).

Prepares machine: Oils machine by filling reservoirs and by oiling bearings, using oil can; fills circulating system (depending on type of machine) with cutting lubricant. Brushes machine, or wipes it with cotton waste, to remove dirt, shavings and drillings. Obtains cutting tools, drills, stops and jigs or fixtures from stockroom. Inserts the required tools in their appropriate stations; may sharpen cutting tools by applying against electrically powered abrasive wheel. Selects the appropriate jaw chuck, jig or fixture, for holding the work in machine, and screws or fastens them into position with hand wrench. Clamps work onto face plate with jig, jaw chuck, or fixture, and alines the work under drill, grinder or cutting tool with hand wrench. Set-up is examined by foreman and adjusted or completed.

Operates machine: Turns wheel to position drill, grinder, or cutting tool for beginning cut, tap, threading or drilling operation. Moves lever to shift gears or moves belt or pulleys to obtained desired spindle speed; engages clutch starting spindle rotation; engages clutches starting cutting, grinding, or drilling mechanism. Stops machine periodically to inspect work with micrometer or caliper, using measuring device carefully to obtain proper setting when checking work to tolerances specified in blueprints. Positions lever to stop machine when work is completed; removes work from table and places it in hand truck.

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Prepares machine: Oils machine by filling reservoirs and by oiling bearings, using oil can; fills circulating system (depending on type of machine) with cutting lubricant. Brushes machine, or wipes it with cotton waste, to remove dirt, shavings and drillings. Obtains cutting tools, drills, stops and jigs or fixtures from stockroom. Inserts the required tools in their appropriate stations; may sharpen cutting tools by applying against electrically powered abrasive wheel. Selects the appropriate jaw chuck, jig or fixture, for holding the work in machine, and screws or fastens them into position with hand wrench. Clamps work onto face plate with jig, jaw chuck, or fixture, and alines the work under drill, grinder or cutting tool with hand wrench. Set-up is examined by foreman and adjusted or completed.

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GPO 918-062